XIX. *On a Cycle of Eighteen Years in the Mean Annual Height of the Barometer in the Climate of London, and on a constant variation of the Barometrical Mean according to the Moon's Declination.* *By* Luke Howard, *Esq., F.R.S.*

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I HAVE already treated this subject, partially and in detail, in the 'Climate of London*.' The further and full development of it in that way will be found an undertaking more of labour than of difficulty, the materials being already provided for doing this through a lunar cycle of eighteen years; but I am enabled, by means of these, to present to the Royal Society some general results, which will prove interesting, and probably important to the science to which they belong.

The like method has been adopted in this paper as in my two former, read before the Society, on the connexion of the barometric variation with the *Lunar Phases* and *Apsides*. I have excluded, by appropriate averages, those effects of the lunar influence which belong not to the subject immediately before us. These, however, will require, whensoever we may think it time to form a theory, to be examined conjointly with the present and every other of the elements of this intricate subject.

Table I.

Barometrical Averages on successive Solar Years, from 1815 to 1832, constructed to show the Moon's influence on the Mean Heights, varying according to her Declination: for the manner of forming which, see the remainder of this paper.

Year.	Days' observations.	Annual mean.	Moon in or near the equator.	Moon at or near her greatest north declination.	Moon in or near the equator.	Moon at or near her greatest south declination.	Averages on nine years.
		in.	in.	in.	in.	in.	in.
1815	370	29·766	29·8391	29·7819	29·7947	29·8880	
1816	368	29·648	29·7883	29·7128	29·7046	29·8357	
1817	362	29·733	29·7908	29·8590	29·8420	29·7499	
1818	369	29·826	29·8116	29·8649	29·8363	29·8348	
1819	361	29·831	29·7930	29·8168	29·9287	29·7106	
1820	369	29·839	29·8014	29·8020	29·9363	29·8622	
1821	362	29·805	29·8206	29·9085	29·7880	29·7044	
1822	362	29·889	29·8543	29·8472	29·9354	29·9426	
1823	369	29·763	29·8040	29·8436	29·6741	29·7203	
1824	368	29·878	29·9788	29·9126	29·9129	29·7546	29·8111
1825	362	29·987	30·0823	30·0285	29·8932	29·9933	29·8235
1826	369	30·033	30·0899	30·0213	29·9959	29·9910	29·8501
1827	362	29·938	29·9374	29·8875	29·9218	29·9829	29·8723
1828	363	29·814	29·8590	29·7832	29·7990	29·8608	29·8848
1829	363	29·688	29·6838	29·6563	29·6857	29·7002	29·8829
1830	368	29·671	29·7404	29·6902	29·6604	29·6900	29·8661
1831	362	29·653	29·6351	29·6310	29·6700	29·5968	29·8512
1832	363	29·702	29·6480	29·8210	29·7293	29·6830	29·8250

The averages on successive periods of nine years in the last column exhibit the barometrical mean, increasing and decreasing, as follows:—29·8111 + 0124 + 0266 + 0222 + 0125 = 29·8848 − 0019 − 0168 − 0149 − 0262 = 29·8250 inch. Then, to complete the cycle, 29·8250 − 0139 = 29·8111 inch.

* Vol. i. p. 172. 2nd Edition.

Table II.

Barometrical Averages on successive Cycles of nine Solar Years, classed according to the Moon's place in Declination.

Periods taken.	1. Moon at or near equator, and going north.	2. Moon at or near her greatest north declination.	3. Moon at or near equator, and going south.	4. Moon at or near her greatest south declination.	5. Averages on whole periods of nine years.	6. Averages on the four results preceding.
	in.	in.	in.	in.	in.	in.
1815–23	29·8114	29·8263	29·8267	29·8054	29·8173	29·8174
1816–24	29·8270	29·8408	29·8398	29·7794	29·8059	29·8218
1817–25	29·8596	29·8759	29·8608	29·8081	29·8366	29·8511
1818–26	29·8929	29·8939	29·8779	29·8349	29·8577	29·8749
1819–27	29·9069	29·8964	29·8873	29·8513	29·8696	29·8856
1820–28	29·9142	29·8927	29·8729	29·8680	29·8691	29·8870
1821–29	29·9011	29·8765	29·8451	29·8500	29·8518	29·8682
1822–30	29·8922	29·8523	29·8304	29·8484	29·8372	29·8560
1823–31	29·8678	29·8282	29·8014	29·8100	29·8123	29·8269
1824–32	29·8505	29·8257	29·8076	29·8058	29·8076	29·8225
Mean by the columns.	29·8724	29·8608	29·8450	29·8261	29·8365	29·8511

The averages presented at the foot of columns 1 to 4, show a decrease in the barometrical mean, consequent on the moon's varying positions in declination, which may be thus stated: 29·8724 in. on equator, *minus* by north place, ·0116 in.; again, *minus* by passage of equator south, ·0158 in.; again, *minus* by south place, ·0189 in.; lastly, *plus* by return north over equator, ·0463 in.

The averages in columns 5 and 6 exhibit the barometrical mean, increasing and decreasing with great regularity, during the course of a lunar cycle of eighteen years.

The averages which form the two Tables before us were obtained in the following manner:—

1. The *year* was divided, by an ephemeris, into periods of lunar declination, the whole set in each case including not less than 361, nor more than 370 days.

2. These periods of declination were subdivided into *weeks* (or spaces of from six to eight days, generally *seven*) with the moon's extreme north, her extreme south, and her respective positions on the equator, coming and going, placed as nearly as might be *in the midst of the space* on which the average was taken—to wit, the average of the *medium heights* of the barometer for each twenty-four hours of the space.

3. These weekly averages, obtained generally from the curves inscribed by the barometer, on the face of a clock by Cumming, in my possession, were then placed under their respective heads of the four positions of the moon above-mentioned.

4. They were then laid together for the whole year, or for the number of days necessarily so accounted, which numbers make an average of $365\frac{1}{3}$ days to the year.

5. Averages were, lastly, taken under the respective heads of north, south, &c. on successive *periods of nine years*, as 1815–23, 1816–24, &c., the series beginning 23rd December 1814, and ending 19th December 1832. These results occupy the four leading columns of the second Table; the preceding are in Table I.

6. The leading column in Table I. contains a set of *annual barometrical means* taken (with the exception of the last) from those I have already published in the 'Climate of London.' These are calculated from the Tables for each month in the ordinary way, and not on the solar years. I have given them as they stand in that work, though in the years from 1815 to 1817 they ought possibly to be higher by a tenth of an inch, from the too high placing the scale in those years; but this (with other like inaccuracies which may be hereafter found and rectified) I do not consider as affecting much *the proportions found among the results in any given year*. In calculating the set of averages on periods of nine years, placed in the last column of this Table, I have, however, to prevent discrepancies, *added* this tenth of an inch upon each of the three years.

7. The fifth column of Table II. contains the barometrical mean, calculated upon the whole period of solar years, which, in the four preceding columns, are averaged under the respective lunar positions of north, south, &c. The sixth column of this Table shows a mean founded on a direct average of the four results placed under these heads. I have noticed some features of the variation at the foot of the Tables. I shall proceed now to state some general results, of course as to the barometer alone. The effects on the mean temperature and rain must for the present be left unnoticed.

The barometrical mean in our climate is depressed (on an average of years) by the moon's position in south declination.

In every one of these averages upon periods of nine years, in Table II., the mean under *south* is lower than that under *north* declination; the difference being in some cases between six and seven hundredths of an inch: and it is larger on the averages in the fore-part than on those in the latter part of the series.

The mean under *south* declination is also *lower than either of the other three*; with exception of the four latter averages, in which it exceeds a little that of the position "going south."

This depression is gradual: it commences with the moon in full *north* declination, and proceeds through her remaining positions to the time when she again crosses the equator to return north; at which season the whole weight that had been abstracted is suddenly restored—this of course must be understood of the small differences in the mean here treated. There will be found, in the observations employed, an abundance of particular cases of variation which contradict such a rule, but the *compensations*, it appears, cover these in its favour.

We have here, I think, evidence of a great *tidal wave* or swell in the atmosphere, caused by the moon's attraction, preceding her in her approach to us, and following slowly as she departs from these latitudes. Were the atmosphere a calm fluid ocean of air of uniform temperature, this tide would be manifested with as great regularity as are those of the ocean of waters. But the currents, uniformly kept up by the sun's varying influence, effectually prevent this, and so complicate the problem.

There is also manifest in the lunar influence *a gradation of effects*, which is here

shown, as it is found to operate *through a cycle of eighteen years.* In these, the mean weight of our atmosphere increases through the fore-part of the period; and, having kept for a year at the maximum it has attained, decreases again through the remaining years to a minimum; about which there seems to be some fluctuation, before the mean begins to rise again.

This result is brought out in different ways by all the averages upon *years*; and it pervades, though with less of uniformity, those upon the quarter periods or *weeks* of declination. The study of these, *with a view to theory*, rude and imperfect as they are, may become, I would willingly hope, an occupation for those more capable and better prepared than myself to grapple with the subject.

L. H.

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